Introduction

Chapter Overview

The U.S. economy approaches the end of the 20th century with unprecedented real growth, miniscule inflation, low unemployment, and strong consumer and investor confidence. Economists have dubbed it the "Cinderella economy." The reasons for this success are many and varied. However, it can be argued that technological change has been behind the economic boom of the late 1990s.

Technological change has three general effects on the economy. First, it reduces the costs of producing goods and providing services. That is, technological change allows for the consumption of greater amounts of goods and services, without the use of greater amounts of human labor, physical capital, or natural resources. Second, technological change is responsible for the creation of new and improved goods and services. Although the relative value of any new product is subjectively determined by each individual, the spending patterns of consumers overall often reveal the preferability of these new products over their predecessors. Ironically, the third factor—what technological change has not yet done, but is expected to do—may have made the greatest contribution to the recent economic boom. Technological change is expected to continue to transform many aspects of economic production, distribution, and consumption. Such changes include, for example, further development of Internet commerce (e.g., banking and retail operations), additional advances in biotechnology (e.g., "designer" drugs), greater automation in production (e.g., advanced robotic systems), new forms of household entertainment (e.g., digital video disc entertainment systems), and new ways of conducting scientific research itself (e.g., the creation of virtual laboratories). Investors and public planners have continued to devote new resources to preparing for these changes, thereby stimulating economic investment and expansion. Thus, much of the current investment-led economic growth is only a prelude to future advances. In this sense, our present is being influenced largely by our future—a future that will owe much of its character to technological change.

Of course, innovation—and the technological change that results from it—does not just happen. It has to be paid for—through expenditures on research and development (R&D). How R&D funds are spent helps determine how scientific knowledge will accumulate and how technological change will be manifested. Thus, R&D decisionmaking—how much different organizations spend and on what areas of science or engineering—is critical to the future of the U.S. economy and national well-being. This factor explains why the United States and many other nations collect extensive R&D expenditures data and disseminate the information worldwide for study by analysts in a wide variety of fields.

In addition to indicating the directions of technological change, R&D expenditure data also measure the level of economic purchasing power that has been devoted to R&D projects as opposed to other economic activities. Industrial (private sector) funding of R&D, for example—which represents most of R&D expenditure in the United States—may be interpreted as an economic metric of how important R&D is to U.S. companies, which could have easily devoted those same funds to any number of other business activities. Likewise, government support for R&D reflects government and society's commitment to scientific and engineering advancement, which is an objective that must compete for dollars against other functions served by discretionary government spending. The same basic notion holds for other sectors that fund R&D, such as colleges and universities and other nonprofit organizations.

Total R&D expenditures therefore reveal the *perceived* economic importance of R&D *relative* to all other economic activities. Because institutions invest in R&D without knowing the final outcome (if they did, it would not be R&D), the amount they devote is based on their perception, rather than their absolute knowledge, of R&D's value. Such information about R&D's perceived relative value is also extremely useful for economic decisionmaking. For example, increased R&D in a particular field of study may reflect an increase in demand for scientists and engineers to study and work in that field. An increase in R&D in a particular industrial sector could be among the first signs that the sector is about to expand with new lines of products or services. Of course, R&D data alone are not enough to accurately analyze the future growth of a field of study or an industrial sector, but they may well be an important input into such analysis. This chapter therefore presents information that will provide a broad understanding of the nature of R&D expenditures and the implications of these data for science and technology policy.

Chapter Organization

This chapter has two major parts, both of which examine trends in R&D expenditures. The first part looks into R&D performed in the U.S. alone; the second compares R&D trends across nations. The first part contains sections on economic measures of R&D; trends in financial support for R&D; trends in R&D performance; industrial R&D performance; R&D performance by geographic location, character of work, and field of science; and intersector and intrasector R&D partnerships and alliances. The second part contains sections on total and nondefense R&D spending; ratios of R&D to gross domestic product (GDP) among different nations; international R&D funding by performer and source; the character of R&D efforts (or R&D efforts separated into basic research, applied research, and development components); international comparisons of government R&D priorities; comparisons of government R&D tax policies; the growth in public- and private-sector international R&D agreements and alliances; the United States' international R&D investment balance; and patterns in overseas R&D and foreign R&D performed in the United States, in terms of both expenditures and facility placement.